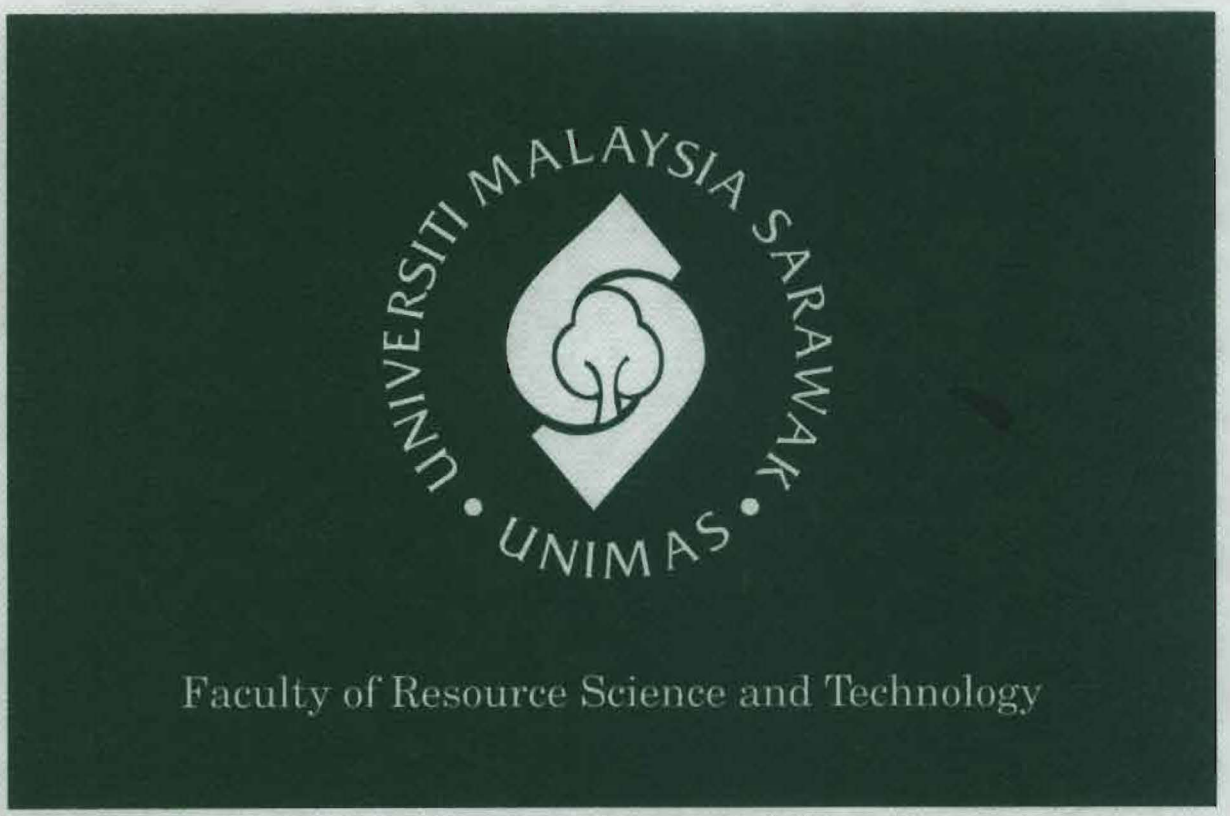


THE PIERIDAE (LEPIDOPTERA : RHOPALOCERA) OF SARAWAK : SYSTEMATICS AND DISTRIBUTION

Bong Shiek Leng

Bachelor of Science with Honours
(Animal Resource Science and Management)
2005

THE PIERIDAE (LEPIDOPTERA: RHOPALOCERA) OF SARAWAK: SYSTEMATICS AND DISTRIBUTION

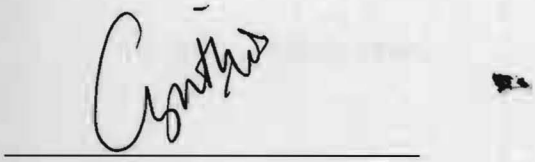
BOON SHIEK LENG

This project is submitted in partial fulfillment of the requirements for the degree of
Bachelor of Science with Honours
(Animal Resource Science and Management Program)

Faculty of Resource Sciences and Technology
UNIVERSITI MALAYSIA SARAWAK
2005

DECLARATION

No portion of the work referred to in this dissertation has been submitted in support of an application for another degree of qualification of this or any other university or institution of higher learning.



Boon Shiek Leng

Program of Animal Resource Science and Management
Faculty of Resource Sciences and Technology
University Malaysia Sarawak

Acknowledgement

Foremost I would like to express my indebtedness to my beloved supervisor Assoc. Professor Dr. Fatimah Abang for being extremely patience and dedication to me and my work. Without her guidance, constructive comments and correcting my mistakes in doing my research, the objectives of this project could never be achieved.

Special thanks to Miss Audry Mengan, Mr Ngumbang Juat and Mr Jailani Mortada who had sacrificed their time to help me to work in Unimas Museum after office hour, and Mr Yazis and all the staff of Institution of Biodiversity and Environment Conservation (IBEC) for allowing me to complete a part of my work at the institute.

I am grateful to Miss Lucy Chong, Mr Paulus Meleng and Miss Pauline for giving permission and help to me to check the specimens of butterflies in the Sarawak Forest Corporation Research Centre.

Great thanks to my dearest juniors from second year; Pang Sing Tyan, Siti Norfatihah, and Siti Rusilawati for helping to collect and to ensure the accuracy of the data of my project from the Insect Collection of Unimas Museum. Special thanks to my dearest friend Sandra James and Simon Chin for their sustained support throughout my undergraduate years.

Abbreviations:

F – Forewing

H – Hindwing

Up – upperside

Un – underside

♂ - Male

♀ - Female

U- underside (In Appendix)

Table of Contents

List of figures

List of tables

The Pieridae (Lepidoptera: Rhopalocera) Fauna of Sarawak:

Systematics and Distribution

Boon Shiek Leng

Program Sains dan Pengurusan Sumber Haiwan
Fakulti Sains dan Teknologi Sumber
Universiti Malaysia Sarawak

ABSTRACT

As shown by voucher specimens deposited at the Sarawak Museum, studies on the butterflies from the family Pieridae in Sarawak began during the 1800's. The present study was based on voucher specimens deposited in the Sarawak Museum, Sarawak Forest Corporation Research Centre and Unimas Museum. These represent specimens collected from 1893 to 2004. A total of 728 specimens were examined and evaluated. A systematic account of the species and distribution maps are provided .A total of 36 species of Pieridae from nine genera in the subfamily Pierinae and four genera in the subfamily Coliadinae is now known to occur in Sarawak. As revealed by this study, eleven Bornean species, namely *E. alitha gradiens, D. blanca nausicaa, D. pasithoe angustifascia, A. albina albina, A. pandione whiteheadi, A. nepheles dilutior, U. cynis pryeri, P. nishiyamai alpha, C. iudith beta, A. lyncida balambangensis* and *A. paulina insularis* are not known to occur in Sarawak. This study also reveals that seven of the Pierid species that has been documented as to occur only in North Borneo (Sabah) prior to this, is now also reported from Sarawak. These are *D. henningia pandemia, D cinerascen, P. cornelia, P. vollenhovi, E. lacteola, E. sari sodalis* and *E. tominia nabalua.* The butterflies of the family Pieridae are distributed throughout different types of forests in Sarawak and are mostly found in peat swamp forest, mixed-dipterocarp forest and secondary forest. 20 families of hosplants for the butterflies of the family Pieridae in Sarawak are revealed by this study. Further research on the butterflies of family Pieridae in Sarawak should be conducted for more detailed biological and ecological information.

Key words: Butterflies, Pieridae, Sarawak, voucher specimens, distribution.

ABSTRAK

Spesimen baucer yang terkumpul di Muzium Sarawak menunjukkan bahawa kajian rama-rama dari famili Pieridae di Sarawak bermula 1800an. Kajian ini adalah berdasarkan spesimen baucer yang tersimpan di Muzium Sarawak, Pusat Penyelidikan Korperasi Perhutanan Sarawak serta Muzium Unimas dari 1893 hingga 2004. Akaun sistematik serta peta taburan disediakan. Sebanyak 728 spesimen telah diperiksa dan direkodkan. Sejumlah 36 spesies rama-rama Pieridae dari 9 genera dalam subfamili Pierinae dan 4 genera dalam subfamili Coliadinae telah didokumentasikan. Menurut kajian ini, sebelas spesies Borneo didapati tidak wujud di Sarawak iaitu; E. alitha gradiens, D. blanca nausicaa, D. pasithoe angustifascia, A. albina albina, A. pandione whiteheadi, A. nepheles dilutior, U. cynis pryeri, P. nishiyamai alpha, C. iudith beta, A. lyncida balambangensis dan *A. paulina insularis manakala tujuh spesies yang dikenali hanya terdapat di Sabah, kini dilaporkan di Sarawak iaitu, D. henningia pandemia, D cinerascen, P. cornelia, P. vollenhovi, E. lacteola, E. sari sodalis* dan *E. tominia nabalua . Rama-rama famili Pieridae bertaburan di pelbagai jenis hutan di seluruh Sarawak dan kebanyakannya ditemui di Hutan Paya, Hutan Hujan Tropika dan Hutan Sekunder.Didapati bahawa 20 jenis famili tumbuhan merupakan tumbuhan perumah rama-rama Pieridae di Sarawak Kajian lanjutan harus dijalankan untuk mendapati informasi yang berkaitan dengan biologi dan ekologi rama-rama Pieridae.*

Kata kunci: Pieridae, Sarawak, baucer specimen, hutan, taburan.

1.0 Introduction

Systematic studies of butterflies in Sarawak started during the colonial days, in the early 19th century. Most early works were published in the Sarawak Museum Journal and the Journal of the Malay Branch of the Royal Asiatic Society (Abang *et al.*, 1996). Among the contributors to the study of butterflies in Sarawak were Shelford (1901), Distant and Pryer (1887), Pryer and Cator (1894), and Bartlett (1896) (Abang *et al.*, 1996). However no comprehensive studies of butterflies have been done in Sarawak except those of Moulton (1915), Otsuka (1988) and Seki and Otsuka(1991) which mostly deal with the butterflies of Borneo. Best (1969) presented a list of butterflies caught around Kuching, Sarawak.

Despite being well known taxonomically, knowledge on the systematics and distribution of the butterflies of Sarawak is very much lacking.

Butterfly is an ideal bioindicator species because it is sensitive toward changes in biotic or abiotic conditions. Hence, it is important to inventory them because they are important monitors of the environment. Species inventory can be based on existing materials. These often document the presence of a species in time and space; and in addition such records also provide a historical perspective, which has important conservation implication in knowing the rate and extent of species increase or decline (Heywood, 1995). Furthermore, inventory and monitoring will aid in identifying and assessing the dynamic impact of keystone species as ecosystems are altered directly or indirectly by human activities.

Secondly, such study serves as fundamental baseline data of basic inventory information that are significant for biodiversity conservation planning, management and with the databases will enable long term monitoring and analyzing of global change.

Therefore, cataloguing and developing taxonomic baseline information of a

group of animals into valuable information is important in order to facilitate the subsequent retrieval of distributional data and preparation of faunistic analyses (Mayr and Ashlock, 1991).

Like other butterflies in Borneo, the family Pieridae has been studied since the 18th century. According to Wallace (1867), the Pieridae forms an extensive group of diurnal Lepidoptera abundantly distributed all over the world. Most of the Pierids are known as white or, yellow or sulphur butterflies (Romoser & Stoffalono, 1994).

The primary objectives of this study were to study the systematics of the Pieridae of Sarawak and map its distribution. The secondary objective was to develop a retrievable database pertaining to the Pieridae of Sarawak.

2.0 Literature review

2.1 Sarawak

Located north of the Equator between latitude 0° 50° and 5°N and longitude 109° 36' and 115° 40' E. Sarawak stretches some 800km along north-west coast of the island of Borneo (Anon, 2004). Topographically, Sarawak maybe broadly classified into three principal terrain groups: the alluvial coastal plain, the mountainous interior and the central belt of generally undulating country between the coastal plain and the interior. Being situated in the tropical region, the greater part of Sarawak is still covered by primary forest and large portions of the area are practically uninhabited.

More than 67% or 8.22 million hectares (ha) of Sarawak's 12,398,500 hectares of land is under natural forest cover. The rest are secondary forests, agricultural and urban lands (Anon, 2004). On account of its immense richness in plants and animals species, Borneo (Sarawak) is a centre of biodiversity in tropical Asia (Hazebroek and Abang Morshidi, 2000).

2.2 Climate

Sarawak is a tropical state with an equatorial climate; it is hot and humid throughout the year with an average daily temperature ranging from 23°C during the early hours of the morning to 32°C during the day (Anon, 2004). The annual rainfall is high averaging 390 centimetres in Kuching, with high rain fall in some parts of the mountainous interior of Sarawak (Polunin, 1992). According to Payne (1994), some of the mountainous areas of Sarawak receive over 5,000 millimetres (200 inches) of rain fall annually. Rain fall pattern in western Borneo (Sarawak) are affected by the monsoon wind of the South Asian region, which tends to bring heavy rains around November to February and May to June.

The relative humidity ranges from well above 90% in the early morning to around 60% in the mid-afternoon on open ground, whilst in disturbed forest there is little changes in day and night; being invariably above 90% (Hazebroek and Abang Morshidi., 2000).

Butterflies are very dependent on climate. According to Ivo (2000), temperature is a basic factor controlling the life of butterflies and moths because they are cold-blooded animals and have to derive their body heat on different stages in the life cycle (Smart, 1991). In addition, relative humidity in Sarawak possibly favours the adaptability of butterflies in the tropics because the females lay eggs in places where the required humidity is obtained. The pupation stage of butterflies is also sensitive to humidity (Ivo, 2000).

2.3 Forest type

Butterflies are world wide in distribution, however, as with most animal groups, a greater diversity of butterflies is to be found in the tropics (Smart, 1991). According

to Kamaruddin (1992), normally the distribution of the Lepidopteran fauna correlates with the plant community in the forest and the elevation of geographical locations.

Every green tropical rain forest is the natural vegetation of the whole of Sarawak, except for small areas on beaches, rives banks and rocky cliffs (Hazebroek and Abang Morshidi, 2000). Floristically, the tropical rain forests are the richest of all major plant communities on earth, and Sarawak' rain forest is one of the richest among them. A huge number of tree species, exceeding 2500, are found in Sarawak's forests (Anderson, 1980). These tree species usually form mixtures, so that in any given area a large number of species are found. The appearance of the forest varies considerably between different parts of Sarawak. This is caused mainly by variations in floristic composition (the species mixture) and structure (e.g. height of the trees, layering of the canopy). These variations are distinct and allow recognition of several forest types (Fig. 2.1).

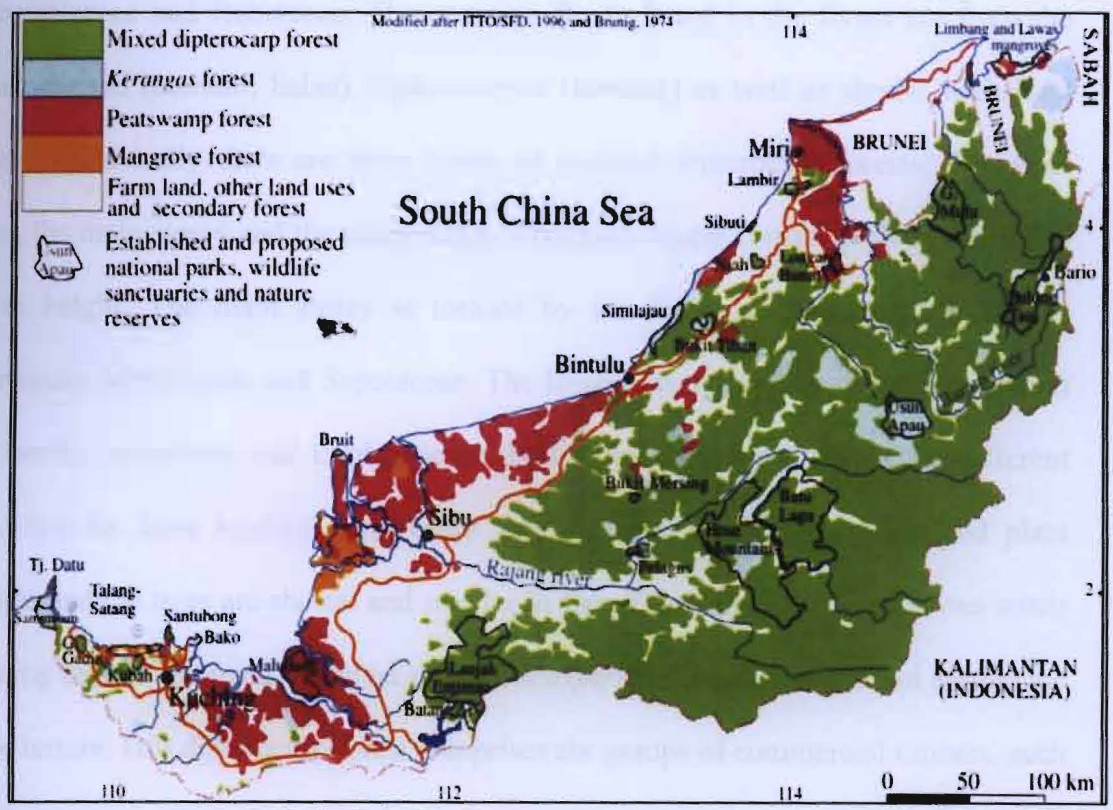


Fig. 2.1: Major forest types in Sarawak (After Hazebroek and Abang Morshidi, 2000.).

2.3.1 Mixed dipterocarp forest

In the Sunda region, trees of the family Dipterocarpaceae predominate to a marked degree in the local representatives of the lowland and lower montane formation (hill dipterocarp forest). These are known as mixed dipterocarp forest (Cranbrook and Edwards, 1994).

According to Hazebroek and Abang Morshidi (2000), mixed dipterocarp forest is the richest forest in Sarawak and estimated to contain over 2000 tree species and the most intensive. No other tropical rain forests anywhere in the world show such abundance and diversity of a single family of big trees (Whitmore, 1984). Thus, it represents the peak of rain forest development in Sarawak. Mixed dipterocarp forest is a high forest, with a deep, dense canopy and the upper surface of which is usually very uneven. Kamaruddin (1992) described lowland forests as consisting of plant families of Dipterocarpaceae, Euphorbiaceae, Myrtaceae, Myristiceae, Sapotaceae, Gutticeae, Flacourtiaceae and Rubiaceae. The common floras found in the forest are from the genus *Shorea* (meranti, balau) *Dipterocarpus* (keruing) as well as shrubs, herbs and climbers. Basically there are three layers of lowland dipterocarp forests; the upper layer, the main storey and the understorey. The upper layers consist of trees with 30 to 40 m height. The main storey is formed by the family Burseraceae, Guttiferae, Myrtaceae, Myristiceae and Sapotaceae. The lowest layer is dominated by trees from the family Annoaceae and Euphorbiceae. Hill dipterocarp forest comprises different plant species from lowland dipterocarp forest. There are not many lowland plant species and the trees are shorter and smaller in size. There are many *Eugeissona tristis* growing around the track, however many *Oncosperma horridum* are found around the slope terrain. Hill dipterocarp forest comprises six groups of commercial timbers, such as *Shorea laevis, Shorea multiflora; Dipterocarpus sp.* Based on a study of butterfly in Belalong, Cranbrook and Werger (1994) reported 324 species from the lowland forest

(Cranbrook and Edwards, 1994). This shows that a relatively high abundance and diversity of butterflies are found in lowland forests compared to other types of forests. Such forest dwellers include *Leptosia nina, Faunis stomphax* and *Charaxes durnfordi.*

2.3.2 Peat swamp forest

Bornean swamp forests are of three major types: mangrove, freshwater and peat swamp; there are differences in nutrient input and vegetation compositions (Mackinnon *et al.*, 1996). Sarawak consists a total of a 1.04 million ha of peat swamp forest (Chen and Balu, 2002), especially around the coastal plains (Mackinnon *et al.*, 1996).

According to Payne (1994), more than 600 species of flowering plants can be found in peat swamp forest, such as *Gonystylus bancanus* (ramin) and *Shorea albida*, jelutong trees. The protected peat swamp areas in Sarawak include Loagan Bunut and Maludam National Park.

Anderson (1980) recorded 927 species of flowering plants and ferns from 224 genera and 70 families from peat swamp forest in Sarawak (Mackinnon *et al.*, 1996). However, peat swamp forests are generally considered as florally impoverished. Accordingly, the butterfly fauna is less diverse in swampy area compared to low land forest.

2.3.3 Montane

Montane forest is a type of forest in the montane zone. It differs in floristic composition and ecological character from those found in lower elevations in the same latitude and in both respects often has strong affinities with forest found in the

lowlands of adjacent higher latitudes (Allaby, 1998).

Less than one percent of montane forest is found in Sarawak. The most classical examples of this type of forest in Sarawak are Gunung Murud and Gunung Mulu which are clothed in a distinctive forest above latitude of 1000 to 2000 metres where many species typical of mixed dipterocarp forest are found (Hazebroek and Abang Morshidi, 2000).

The band of lower montane forest between 1,200 and 1,600 metres is made of trees no more than 40cm in diameter, the top most canopy of only 15 metres high only (Payne, 1994). According to Hazebroek and Abang Morshidi. (2000), in montane forest, the overall diversity of the animal life is very much reduced. This is due to the smaller number of fruit tree species which results in a smaller number of niches. Moreover, the climates in montane forests are cool and moist therefore there is a less diverse butterfly fauna in the montane forest as compared to the lowland forest (Holloway, 1984). Nevertheless, a number of butterfly species are known to be endemic to montane region in Borneo. Among these are *Delias ninus parthenia, Ptychandra talboti*, and *Parantica crowleyi* (Holloway, 1984).

2.3.4 Mangrove forests

Mangrove forests owe their existence to salt water, and are adapted to the daily flooding by tide, hence the elaborate root structure to anchor the trees in the muddy waterlogged soil, and the presence of pneumatophores on the root of most species (Mackinnon *et al.*, 1996).

The Sarawak mangrove forests are dominated by *Sonneratia alba* along sheltered parts of the coast with saline sand and clay, *Rhizophora mucronata* (Bakau kurap) and *Nypa fruticans* (Nipah palms) (Hazebroek and Abang Morshidi, 2000).

Apart from these, 29 epiphytes (including 10 orchids and 11 ferns) and about 51 species of fungi inhabit the mangrove forests (Chai, 1982). Butterfly species that are normally associated with mangrove forest are *Saletara panda* and *Appias nero*.

2.3.5 Limestone forest

Limestone outcrops cover about 520 km^2 of Sarawak, mainly located in southern Sarawak (Banda *et al.*, 2004). Rugged limestone hills form a striking part of Sarawak landscape in Gunung Mulu, Niah Park and Bau-Serian areas (Hazebroek and Abang Morshidi, 2000).

Limestone areas are commonly valued as cultural heritage sites and are important sites of archaeological and anthropological discoveries (Lapis and Bernadette, 2004). Apart from that, they also have rich and very distinctive flora with more than 600 recorded species (Chai, 1982). For example, many of the most notable members of Gesneriaceae and the Begoniaceae are endemic to the Bau limestone Area (Kiew *et al.*, 2004).

According to Karim and Abang (2004), a comparatively high number of butterfly species was recorded of the Bau Limestone Area with a total of 195 species collected. This indicated that limestone areas also sustain high butterfly diversity.

2.3.6 Kerangas forest or tropical Heath forest

Heath forest is a distinctive kind of tropical rain forest, with sclerophyllous and microphyllous leaves, found in south-eastern Asia, South America, and central Africa. It grows on siliceous podzolic soils (Allaby, 1998). According to Proctor *et al.* (1982), heath forest occurs on allegedly infertile, usually sandy soil, or on soils derived from

basic igneous or volcanic rocks, such as basalts. This description is in accordance with the name given to heath forest by the Ibans, that is Kerangas. It means 'land which will not grow rice' (Allaby, 1998).

Brunig (1974) recorded 849 tree species, 133 shrubs, 96 herbs, 100 epiphytes and 55 lianas in Sarawak's Kerangas forests. Ground orchids and ferns may locally abound in more open vegetation. Certain species, such as *rhu ronang* (*Gymnostoma nobile*), kawi (*Whiyeodendron moultonianum*), and kerukup (*Shorea pachphylla*) are typical of Kerangas forest (Hazebroek and Abang Morshidi, 2000). The occurrence of carnivorous plants like *Nepenthes* probably indicates nitrogen deficiency in the soil (Polunin, 1992). This forest is easily degraded by felling and burning into an open savannah of shrubs and scattered trees over a sparse grass ground layer (Whitmore, 1984). An example of Kerangas forest/ heath forest is found at the Bako National Park in Sarawak. Generally, heath forest is poor in animal life, including butterfly.

2.3.7 Beach forest

According to Whitmore (1992), beach vegetation has two facies (Whitmore, 1984). Along accreting coasts the initial vegetation is the *pre-caprae* association, a low, herbaceous plant cover of which most members are creepers. The second facies is the beach forest, most of whose species in eastern rain forest.

Less than one percent of the Beach forest is distributed in Sarawak and it is mainly formed by sandy soils (Hazebroek and Abang Morshidi, 2000). Plant species of these forests are either wind dispersed (*Casuarina equisetifolia*) or water dispersed (*Calophyllum inophyllum* and *Barringtonia asiatica*) (Whitmore, 1992). There are about 15 to 20 species of trees, shrubs and herbs in Sarawak beach forests. Butterfly species frequently found along the seashore are *Appias albina* and *Captosilia pyranthe*

(Otsuka, 2001).

2.4 The characteristics of Pieridae

The Pierids are generally small to large butterflies, ranging from approximately 25mm to 100mm in size (Smart, 1991); however, most are of medium size though a few, such as *Leptosia* are small and fragile while members of the Oriental genus *Hebomoia* are larger than many Papilionidae. Unique among butterflies is the universal occurrence of bifid tarsal claws (Fig. 2.2), otherwise found in only a few Papilionidae, Satyrinae, and Lycaenidae. The characteristic white and sulphurous yellows, and the reds of the more colourful tropical species, are produced by pteridine pigments that are found in few other Lepidoptera (Bascombe *et al.*, 1999). The whites are a large and wide spread group which have white and cream colours; normally the underside of the hind wings is bright coloured (Feltwell, 1993). In the yellow species, the underside is brighter than the upper side (Corbet and Pendlebury, 1992). A singular feature of the male genitalia, possessed by many members throughout the family, is a sclerotized plate on the ventral surface of the aedeagus posterior to the caecum. Since it appears to be an area of muscle insertion Higgins has named it the trochanter penis (Bascombe *et al.*, 1999).

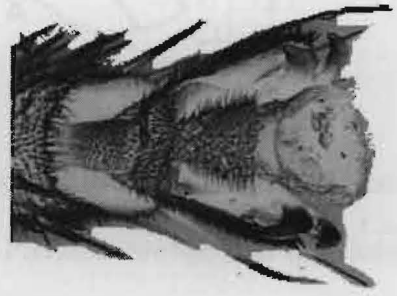


Fig. 2.2: Bifid claws on right hindleg of *Cepora nerissa* (After Bascombe *et al.*, 1999.)

2.4.1 Wing venation

The wings are membranes, with veins or nervures running longitudinal from the base to the wing margin (Corbet & Pendlebury, 1992). They are greatly varied in size, shape and pattern (Fleming, 1975). In butterflies, usually it is the forewing that tends to be bright coloured compared to hindwings (Ivo, 2000).

The wing membrane is reinforced by veins during flight. The veins vary in different groups of Lepidoptera. Almost every family can be characterised by a particular type of venation (Ivo, 2000).

The homologous veins can be recognised as follows: the costa (C), subcosta (Sc), radius (R), media (M), cubitus (Cu), postcubitus (Pcu) and anal (A) (Fig.2.3) and the wing surface and wing margin of wings shown in Fig.2.4.

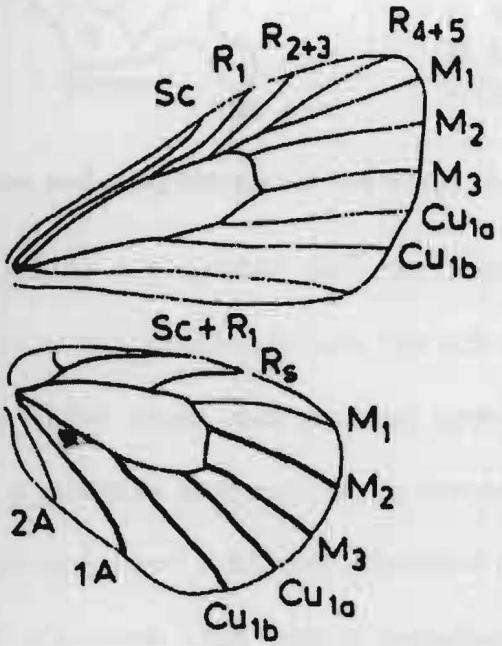


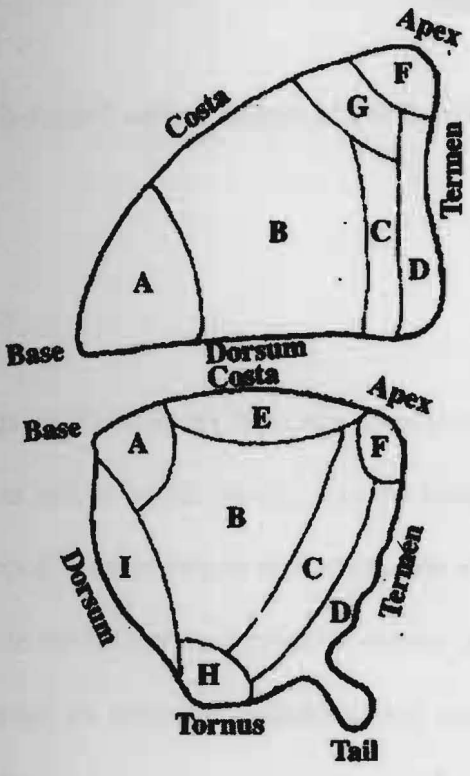
Fig. 2.3: Wing venation of Pieridae (*Pieris*) (After Davies,1998.).

Note formation of discal cell in Pieridae through loss of basal section of media (Davies, 1998)

The following characteristics of Pieridae are based on Bascombe *et al.* (1999).

Eyes naked or with a sparse covering of very short hairs. Antennae of variable length;

club gradual, slim or occasionally broad. Maxillary palpi absent. Labial palpi variable. Tarsal claws of all legs bifids. Forelegs normally developed and functional in both sexes; foretibia without an epiphysis. Mid and hindtibiae with terminal pair of spurs.



A- Basal
B – Discal
C – Submarginal
D – Marginal
E- Costal
F- Apical
G- Subapical
H- Dorsal
I-Tornal

Fig.2.4: Wing surfaces and wing margins of the wings (After Otsuka, 2001.)

The males are readily distinguished from the females by the following characters: male secondary sexual characters (brands, hair tufts or scattered androconia) usually present (Fig.2.6); eighth tergite often produced posteriorly, either as paired dorsolateral flaps or as a middorsal depressed sac (a pseuduncus). Male genitalia: tegumen often with an uncus anticus; a diffusely sclerotized subcaphium sometimes present; valvae not well sclerotized, often with an ampullary process arising from central part of medial wall, sometimes with distal processes, costa attached to tegument by a distinct and usually well sclerotized band; aedeagus usually with a trochanter; vesica nearly always without cornuti.

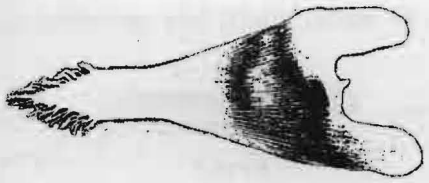


Fig. 2.5: Brush-tipped androconium of *Pieris canidia* (After Bascombe *et al.*, 1999)

2.5 Life History

The eggs of Pieridae are typically spindle-shaped (Smart, 1991), they are two to three times as tall as broad, rarely, tapered towards the micropylar area and have variably developed vertical ridges and transverse striations (Bascombe *et al.*, 1999) ; mostly are white or yellow or orange in colour and laid singly in the majority of species. The larvae are slim and cylindrical and mostly procryptic green or green and yellow. Typically each segment is rugose and bears several bands of short conical tubercles, each ending in a simple small seta (e.g. *Hebomoia*) or stout seta that ends in a thin-walled spherical expansion (e.g. *Eurema*). These cuticular outgrowths extend over most of the head, which usually appears little different from the rest of the dorsal and lateral cuticle and is not concealed at rest. In a few, such as *Cepora* and *Appias*, the integument is partly unpigmented and the larger tracheae are visible. The shape of pupae is elongated, pointed at both ends (Yong, 1993). They are anally attached to a stem of the foodplant and supported, usually in upright position by a girdle (Smart, 1991). Many are suspended beneath an angled or horizontal surface like those of the Papilioninae; others are less particular about their posture and may be found at any angle, head upwards or downwards, or on top of or beneath a horizontal surface. Those of many species show great variation in colour, from bright green to shades of brown grey (Fig. 2.7)